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Remarks

Thorough examination by the Examiner is noted and appreciated.

The Specification has been amended to correct grammatical errors and overcome Examiners objection.

The claims have been amended to clarify Applicants disclosed invention and new claims added. No new matter has been added.

For example, support for the claims is found in the Specification at paragraph 0035 and Figures 2A and 2B.

"The tungsten etchback process typically includes two steps. In the first step, 90% of the tungsten layer 40 is etched at a high rate with excellent uniformity. In the second step, the etch rate is reduced and a gas chemistry is reduced with a high selectivity to the barrier layer 37. The etch reduction serves to decrease gas pressure and wafer temperature to reduce loading effects that may cause recesses in the tungsten plugs 42."

And at paragraph 0036:

"Accordingly, as shown in FIG. 2E, the oxidant solution 48 thoroughly

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dissolves and removes the tungsten residues 44 from the structure 29."

And at paragraph 0030:

"The oxidant solution oxidizes and dissolves the tungsten residues, preparatory to deposition of a top metal layer on the top dielectric layer. The top metal layer is disposed in electrical contact with the bottom metal layer through the tungsten plugs."

Support for the new claims 21-26 is found in the Specification at paragraph 0032:

"Such oxidant solution includes about 4.56-8.05, and preferably, about 7.17 wt. % catechol; about 5.13-8.21, and preferably, about 6.93 wt. % diglycolamine; about 1.63-2.58, and preferably, about 2.21 wt. % gallic acid; about 11.70-13.44, and preferably, about 12.06 wt. % hydroxylamine; about 24.76-27.50, and preferably, about 26.03 wt. % moisture; about 22.46-27.94, and preferably, about 25.36 wt. % monoethanolamine; and about 18.98-23.02, and preferably, about 21.12 wt. % monoisopropanolamine."

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chemistry is reduced with a high selectivity to the barrier layer 37. The etch reduction serves to decrease gas pressure and water temperature to reduce loading effects that may cause recesses in the tungsten plugs 42."

Claim Rejections under 35 USC 102

1. Claims 1 and 2 stand rejected under 35 USC 102(b) as being anticipated by Honda et al. (US 5,780,406).

Honda et al. disclose a non-corrosive cleaning composition for removing **plasma etching residues without metal layer corrosion following a resist removing process** (etching with resist mask) (see abstract; col 2, lines 17-24). Honda et al. teach adjusting the pH of the cleaning solution to between 2 and 6 with both an acidic and basic component and further teaches that the cleaning composition may be used **following an oxygen plasma or wet stripping methods to remove photoresist** (see col 4, lines 40-43).

Thus Honda et al. do not disclose several aspects of Applicants disclosed and claimed invention.

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Nowhere do Honda et al. disclose a metal planarization to form metal residues or the removal of oxidized metal residues.

Rather, Honda et al. disclose the use of a cleaning solution **non-corrosive to metal** following a metal etching process with photoresist present and an oxygen plasma process to remove photoresist (col 4, lines 60-64).

Nowhere do Honda et al. disclose that the cleaning solution is an **oxidant** or suggest or disclose that it may successfully be used for **oxidizing and removing metal containing etching residues**. Rather, Honda et al. disclose that the cleaning solution **includes hydroxylammonium salts which prevent metal attack** (col 3, lines 42-45).

Honda et al. is insufficient to anticipate Applicants disclosed and claimed invention.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

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"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

2. Claims 1, 2, 5, and 6 stand rejected under 35 USC 102(c) as being anticipated by Koito et al. (US 6,869,921) or Lee et al. (US 2003/0228990).

Koito et al. disclose a composition for **stripping photoresist** including an anti-corrosive compound (anti-corrosive to metals). The stripping composition of Koito et al. is taught to solve the problem of **damage to low-K dielectric layers** and **metal corrosion** when **stripping photoresist** following **etching** an opening into a **low-K dielectric layer** (see col 2 lines 35-54; col 3, lines 8-19)). Koito et al. disclose that **alkanolamines are useful for stripping resist residues** (see col 3, lines 35-37). Koito et al. disclose that their stripping composition is useful for preventing metal corrosion (e.g., metal oxidation and removal) when **stripping resist films where a metal film is exposed on the substrate surface** (col 11, lines 47-59), particularly where **the metal is copper** (where oxidation would **destroy the properties of copper interconnects or plugs**).

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In addition, Koito et al. disclose a via forming process demonstrating the use of the stripping solution to remove etching residues **following etching according to a photoresist pattern** (see col 12, lines 33- 67; col 13, lines 1-28; Figures 1-2d). Koito et al. further disclose a tungsten filling process **following the etching and stripping process** to fill the via hole which is then followed by a CMP planarization to form the tungsten via plug where there is no teaching or suggestion by Koito et al. of use of the **stripping solution** (col 13, lines 25-29).

Thus, Koito et al. do not disclose several aspects of Applicants disclosed and claimed invention.

Koito et al. do not disclose a metal planarization process followed by use of a metal oxidizing solution for remove the metal including oxidized metal.

Koito et al. is insufficient to anticipate Applicants disclosed and claimed invention.

ON the other hand, Lee et al., discloses "A residue remover

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for removing polymeric material and etch residue includes 2-(2-aminoethylamino)-ethanol and optionally another two-carbon atom linkage alkanolamine compound, gallic acid or catechol, water, a polar organic solvent, and hydroxylamine. A process for removing photoresist or other residue from a substrate, such as an integrated circuit semiconductor wafer including titanium metallurgy"... "without attacking titanium or other metallurgy on the substrate"."

Nowhere do Lee et al. disclose a metal planarization including an etchback process or metal residues or an oxidant solution for removing metal residues.

Lee et al. is insufficient to anticipate Applicants disclosed and claimed invention.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail

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as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

With respect to claims 2 and 6, nowhere do Koito et al. disclose that the anti-metal corrosive resist stripping solution comprises an hydroxylamine.

With respect to claim 9, 10, and 12, Examiner is clearly mistaken that Koito et al. teach a process for removing tungsten residues from a tungsten plug structure. Rather, Koito et al. disclose a CMP process for forming a tungsten plug structure and do not disclose or suggest the presence of tungsten containing etching residues following such a process (col 13, lines 25-29) or that their cleaning solution is an oxidant or could successfully be used to oxidize and remove tungsten containing etching residues.

Claim Rejections under 35 USC 103

1. Claims 3, 4, 7, 8, and 11 stand rejected under 35 USC 103(a) as being unpatentable over Koito et al., above, in view of

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Wolf (Silicon processing, Vol. 1, page 51) or Verhaverbeke (US 5,972,123).

Applicants reiterate the comments made above with respect to Koito et al.

Applicants further note that Koito et al. nowhere disclose a metal planarization process including a metal etchback process together with the formation of metal residues from said process, but rather teach away from a cleaning solution that **removes a metal residue including oxidized metal**, as this would defeat the purpose and principle of operation of their **resist stripping solution to avoid metal corrosion**.

Moreover, Koito et al. do not teach, disclose or suggest use of their cleaning solution to remove metal residue following a tungsten CMP process for forming a tungsten plug.

The fact that Wolf or Verhaverbeke disclose that applying a solution for wet etching or cleaning can include a spraying method does not further help Examiner in establishing a *prima facie* case of obviousness.

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"Finally, the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

2. Claims 13, 14, 17, and 18 stand rejected under 35 USC 103(a) as being unpatentable over Koito et al., above, as evidenced by alleged admitted prior art.

Applicants reiterate the comments made above with respect to Koito et al.

Applicants further note that the **resist stripping solution** of Koito et al. which **avoids attacking metal** works by a different principle of operation and accomplishes a different purpose than Applicants disclosed and claimed invention e.g., **removing metal or tungsten residues including oxidized metal or tungsten residues**, a process that would destroy the purpose and principle of Koito et al.'s anti-metal corrosive resist stripping composition and method. Thus, Koito et al. **teach away from corrosion (oxidation and/or removal) of metal materials**, and any

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modification of the method of Koito et al. to achieve Applicants disclosed and claimed invention (make it oxidizing to metal residues) would render the method of Koito et al. unsuitable for its intended purpose.

Even assuming *arguendo* a legitimate motivation for combining the teachings in Applicants disclosure with Koito et al., which Applicants do not concede, the fact that Applicants disclose in the prior art a problem to be solved in the formation of tungsten plugs by an etchback process, which their disclosed and claimed invention solves, and which problem Koito et al. neither recognizes or solves, does not further help Examiner in establishing a *prima facie* case of obviousness.

"Finally, the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"A *prima facie* case of obviousness may also be rebutted by showing that the art, in any material respect, teaches away from

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the claimed invention." *In re Geisler*, 116 F.3d 1465, 1471, 43 USPQ2d 1362, 1366 (Fed. Cir. 1997).

"The prior art must provide a motivation or reason for the worker in the art, without the benefit of appellant's specification, to make the necessary changes in the reference device." *Ex parte Chicago Rawhide Mfg. Co.*, 223 USPQ 351, 353 (Bd. Pat. App. & Inter. 1984).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie obvious*." *In re Ratti*, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).

"If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." *In re Cordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

"A statement that modifications of the prior art to meet the claimed invention would have been "well within the ordinary

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skill of the art at the time the claimed invention was made'" because the references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993).

3. Claims 15, 16, 19, and 20 stand rejected under 35 USC 103(a) as being unpatentable over Koito et al., above, as evidenced by alleged admitted prior art, above, and further in view of Wolf or Verhaverbeke, above.

Applicants reiterate the comment made above with respect to Koito et al., Applicants alleged admitted prior art, and Wolf or Verhaverbeke.

The cited references, singly or in combination, are insufficient to reproduce Applicants disclosed and claimed invention, or to make out a *prima facie* case of obviousness with respect to Applicants independent claims, and therefore Applicants dependent claims.

The Claims have been amended and new claims added to clarify

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Applicants disclosed and claimed invention. A favorable consideration of Applicants' claims is respectfully requested.

Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in condition for allowance for any reason, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

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